SYNOPSIS

Analyzing the Factors Influencing the Consumers' Intentions of Electric Vehicles Adoption in Indian Transportation Sector

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1.0 Introduction:

Transportation is the primary originator of unsustainable energy use depending completely on the petroleum-based fuels. For climate mitigation, decarbonizing the transport is a crucial challenge (Tran et al. 2012). This sector accounts for 25 % of worldwide CO2 emission and is supposed to grow 50% by 2035 (McCollum et al. 2018; Tran et al. 2012). The recent database of World Health Organization (WHO) revealed that India has highest number of most polluted cities in the world in terms of PM2.5. The major contributor to the Greenhouse Gas (GHG) emission in India is road transport sector (Singh et al. 2019). According to Tiwari et al. (2018) the transportation sector has contributed approximately 45% of PM2.5 and 29% of PM10 only in Delhi. Furthermore, this increased road transport GHG emission in India is due to the rapid growth of number of vehicles. Road transport sector has grown at a rate of more than 15% over the last decade (NEMMP 2012). But, the Indian electric vehicle market has the lowest penetration in the world. In this context, electric vehicles (EVs) appear to be turning point in the Indian road transport sector for the GHG emission reduction (Zhang et al. 2018; Adnan et al. 2018). EVs are capable of reducing GHG emission and reliance on fossil fuel (Adnan et al. 2018; Li et al. 2017). Therefore, shifting to EVs cannot only be a significant stride in the direction of reducing Indian oil imports, but can also help in enhancing air quality.

The efforts by the Department of Heavy Industry (DHI) like faster adoption of electric vehicle (FAME) and DHI-DST technology platform for electric mobility (TPEM) are not enough until consumers' preferences of EVs adoption in India are not analysed. Some preliminary work in the GHG emission of air transport by the investigators (Singh & Sharma 2014; Singh et al. 2016; Singh 2016) has inspired the researcher to analyse the consumers' preferences of EVs adoption in India, and to increase the penetration of EVs in the Indian market.

2.0 Literature Review:

International Status:

There are several studies available on the consumer preferences of electric vehicle adoption in the international literature. Some of the work in the last three years is summarized below:

- Adnan et al. (2018) has predicted the Malaysian consumer behaviour in adoption of plug in hybrid electric vehicles (PHEVs). Subjective norm, personal moral norm, perceived behavioural control, environmental concern, and attitude were identified as the major factors influencing PHEVs adoption. However, this study has not considered the important factor such as promotion for PHEVs adoption.
- He and Zhang (2018) study the moral norm to adopt the electric vehicle (EV) in China. Results showed that personal norms have a positive influence on EV adoption intention, and such influence is moderated by external costs, including perceived price and perceived complexity. But the actual adoption behaviors were not considered in this study.
- Kim et al. (2018) identified the factors influencing the slow diffusion of electric vehicle in Korea. The findings identified and prioritized charging concerns as the highest barrier, and burden of costs as another critical barrier. But this study used a relatively small sample size and the public group was limited to drivers with prior knowledge.
- Wang et al. (2018) studied the public acceptance of electric vehicle in Shanghai. Results showed that the technical level, marketing, perceived risks and environmental awareness have significant impacts on EV acceptance. This study was limited to the consumers of private cars with no consideration of the commercial fleets.
- Zhang et al. (2018) studies the subsidized electric vehicle adoption. perceived economic benefits, perceived environmental benefits, and perceived risks were correlated with each other. The factors such as Plate lottery, motivation, and role of policy can be considered in future.
- Degirmenci and Breitner (2017) studied the consumer purchase intensions for EVs. The results showed that the environmental performance of EVs was a stronger predictor than price value and range confidence. However, only the three factors were considered in this study.
- Han et al. (2017) investigated consumers' intention to adopt EV from the consumption value perspective. The results indicated that the perceived functional value have both direct and indirect effects on consumers' intention to adopt EVs. The specific variables such as brand preferences were not considered in this study.

- Javid and Nejat (2017) studied the regional EV adoption and penetration model. The results showed that a household's income, maximum level of education in the household, the buyer's car sharing status, charging stations density, and gas price in the region can significantly impact PEV adoption. The psychographic indicators were absent from this study.
- Mohamed et al. (2016) identified and characterize the potential EV adopter in Canada. Results showed that attitude, perceived behavioral control, and norms have significant direct impact on behavioral intention. Location factors and personal beliefs were not considered in this study.
- Lai et al. (2015) studied the behavioural intention towards the full EV in Macau. The results showed that environmental concerns and the perception of environmental policy were factors of the perception of full electric vehicles, which influences the behavioural intention to purchase full EVs.

National Status:

- In India, there are a few researchers that have been working on electric vehicle adoption in road transport. Related to the EV adoption in road transport, following contributions are traded on the national level in the last decade:
- Dhar et al. (2017) predicted the long-term cost-benefits of adopting the EVs in India and used the energy system model to analyze the role of EV in India. However, the study has only considered the policy related factors for diffusion of EVs in India.
- Cherla and Garg (2017) studied the EVs mobility in India. The study identified the consumer perceptions of EV in India. But the most of the important factors were not considered in this study. In addition, the relationships among various factors were absent.
- Kumar et al. (2015) suggested a strategy to enhance the EVs adoption in India. But in this study no mathematical formulation was to done to identify the factors of EVs adoption.
- Prakash et al. (2014) studied the gender preferences on EVs adoption in India. The results indicated that in general fueled vehicles are still preferred over EV. However, there is a strong interest in EVs in India. The relationships among various factors of EV adoption were not discussed in this study.

3.0 Research Gap identification:

Based on the extensive literature review, the most common research gaps identified are shown in the following table

S. No.	Most common Identified research gaps	References
1	• Detail study on factors influencing EV adoption was missing. Study was not covering the broad area of country.	OLA 2019
2	• Factors on the basis of consumer perception towards EV were not discussed. Current status on innovation and R&D in India was found missing.	ISGF 2019
3	• No quantitative research was carried out. Policy suggestions were purely based on the literature review.	Vidhi et al. 2018
4	• A complete description of state wise policies was missing in the study. Factors influencing market strategy and adoption were absent.	RMI 2017
5	• Policy related factors for diffusion of EVs were only considered in India. The analyses of EV penetration on Indian market were not made.	Dhar et al. 2017
6	• The factors include research innovation and new technologies were not measured in this study. • Additionally there was an absence of relationship among those variables.	Dhar et al. 2017
7	• A procedure of mathematical calculations to find the challenges in EV adoption was not available.	Kumar et al. 2015

4.0 Proposed Objectives:

The present work is undertaken with following objectives:

1. To review the extensive literature on factor influencing the consumer intention towards electric vehicles (EVs) adoption and review of Indian policies.
2. To identify the factors influencing EV adoption in Indian context.
3. To evaluate the factors of the construct, such that they satisfactorily fulfil reliability, validity properties and survey.
4. To find the influence of factors through results and their discussions for co-relation.
5. Finally, it aims to deliver the policies suggestions and recommendations for EV adoption.

5.0 Proposed Methodology:

The description of working innovation (Figure 1) is outlined as follow:

Literature survey & Meta-analysis:

- This segment will perform Meta-analysis and evolves research gaps in the target area.
- Also, this segment will frame the objectives of the research study based on the identified research gaps.

Theoretical framework and Hypotheses development

- This segment will develop a Hypothesis construct on faster adoption of electric vehicles in India.
- Also, this segment will propose a research model based on the hypothesized relationships of each construct.

Questionnaire development and pretesting

- This segment will develop a questionnaire and this questionnaire will be pre-tested by the experts.

Data collection and data screening

- This segment will include the collection of data by using stratified random sampling.
- Also, in this segment Statistical Package for Social Sciences (SPSS) will be used to screen the data of this research.

Data analysis

- This section will analyse the collected data by using exploratory factor analysis, confirmatory factor analysis, and structural equation modelling. After then, the underlying dimensions will be checked for reliability and validity. This will explore the underlying dimensions. Finally, the identified underlying dimensions will lead to develop the Structural Equation Model on the consumer's preferences of electric vehicle adoption in India.

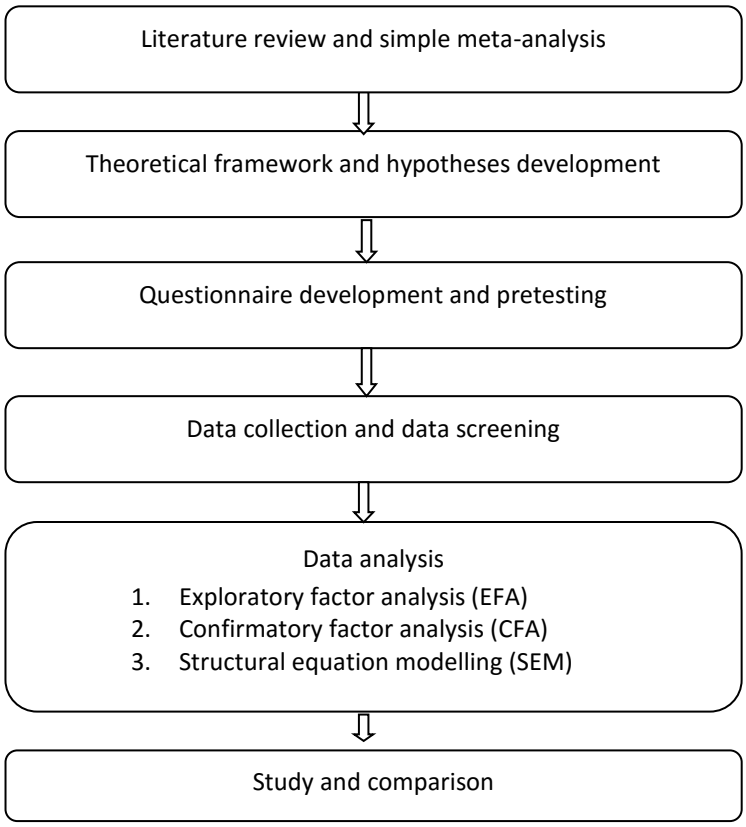
Literature review and simple meta-analysis
Theoretical framework and hypotheses development
Questionnaire development and pretesting
Data collection and data screening
Data analysis
1. Exploratory factor analysis (EFA)
2. Confirmatory factor analysis (CFA)
3. Structural equation modelling (SEM)
Study and comparison

Figure 1: Schematic Diagram for Proposed Methodology

6.0 Thesis Outline:

The detailed thesis outline is as follows:

Chapter 1: Introduction

This chapter will contain the brief introduction to Electric Vehicles and includes aims and objectives of the study

Chapter 2: Literature Review

This chapter will deal with intense review of literature, detailed meta-analysis for research gap identification

Chapter 3: Methodology / Experimental Section

This chapter includes the methodology for achieving the proposed objectives of the study

Chapter 4: Results and Discussions

This chapter will include the detailed discussion of results.

Chapter 5: Summary and Conclusions

The chapter will summarize and correlate all chapters in a lucid manner.

Time Schedule of research giving milestones through BAR diagram:

This research will be continued for three years in the beginning and later will be implemented further. It begins with review of literature survey. It will be followed development of questionnaire, pilot study, and finalizing questionnaire. After this, locations will be identified and seek permissions from government departments for conducting survey. Then, collection of primary survey of prospective and people with an age gap of 18-35 years, 35-55 years and above with their demographic profile. After this data screening, EFA, CFA, and develop SEM model will be performed. Then, correlate the results of this study, it will be presented in national as well as international conferences and published in peer reviewed Sci and Scopus indexed journals. Finally, as per usual procedures, a final report of the work done under this course will be submitted to the School of Engineering and Technology, Department of Mechanical Engineering, Career Point University, Hamirpur. A list of work elements is given below.

0-12 Months:

Task 1 – Course work

7-14 Months:

Task 2 – Literature survey

Task 3 – Identification of research gape

15-20 Months:

Task 3 – Development of questionnaire, pilot study, and finalizing questionnaire

21-28 Months:

Task 4 – Primary survey of students, professionals and existing consumers.

29-30 Months:

Task 5 – Data screening, EFA, CFA, and evolution of SEM models.

31-36 Months:

Task 6 – Debugging and Documentation.

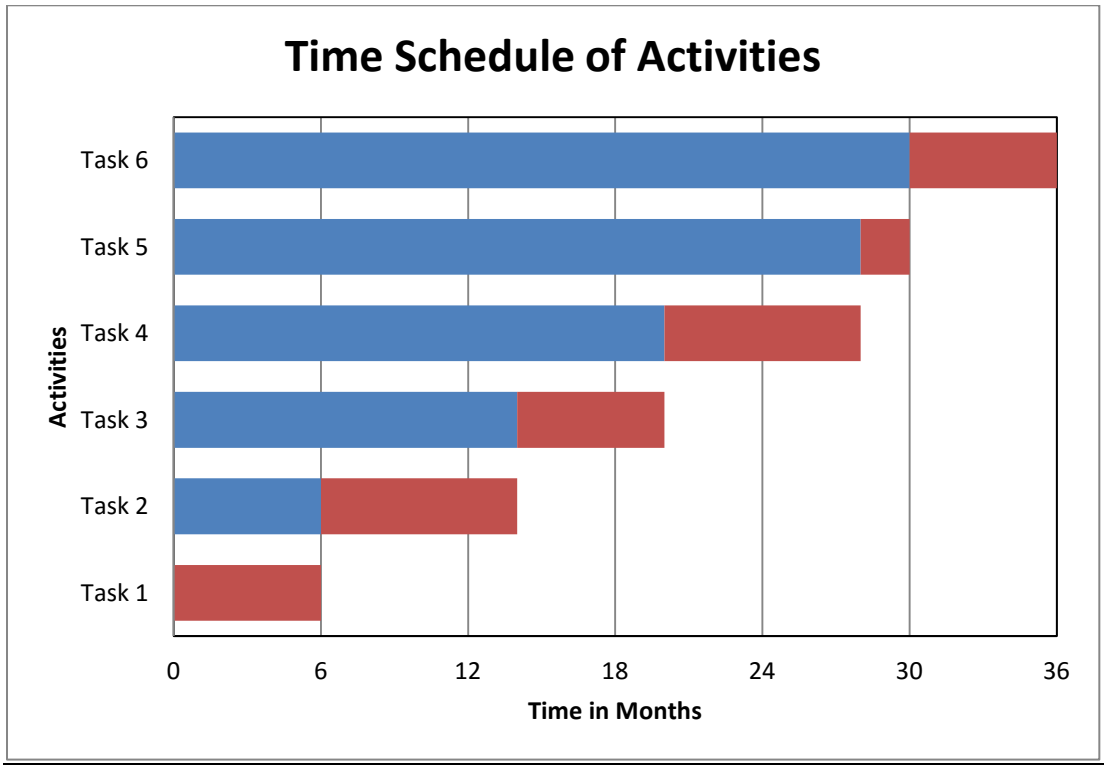

Figure 2: Time Schedule of Activities

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